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Behind the Scenes of the NAS: Human Factors Taxonomy for Investigating Service Integrity Events

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BEHIND THE SCENES OF THE NAS: HUMAN FACTORS TAXONOMY FOR INVESTIGATING SERVICE INTEGRITY EVENTS

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The Federal Aviation Administration (FAA) deployed the Service Integrity Risk Analysis Process (SI-RAP) with the goal of assessing the risk of technical occurrence events where the ability to provide safe air traffic management technical services is compromised. As a post-event tool, SI-RAP assesses the risk associated with an occurrence based on severity and repeatability. The SI-RAP taxonomy was developed to provide a consistent framework for supporting the assessment of event repeatability. The SI-RAP taxonomy synthesizes existing human factors taxonomies with customized factors representing the technical operations domain. The SI-RAP taxonomy is comprised of four tiers: Personnel Factors, Contextual Factors, Equipment Factors, and Systemic Factors—with each tier being composed of categories that group related taxonomy factors. An iPad application was developed to assist SI-RAP panel members in the application of the taxonomy. This paper will introduce the SI-RAP taxonomy, the SI-RAP walkthrough application, and will describe the future application of the taxonomy.

The FAA deployed the SI-RAP in October 2014. Building upon the FAA's (2013) Airborne Risk Analysis Process (Airborne RAP) and EUROCONTROL's (2013) Risk Analysis Tool (RAT), SI-RAP's primary goal is to assess the risk of technical occurrence events when the ability to provide safe air traffic management services is compromised (Berry, Sawyer, & Hinson, 2014). As a post-event analysis tool, SI-RAP assesses the risk associated with an occurrence based on severity and repeatability, with the repeatability portion incorporating a taxonomy of occurrence factors. Furthermore, the SI-RAP taxonomy (Figure 1) incorporates the human factors areas from the Air Traffic Analysis and Classification System (AirTracs) taxonomy (Berry & Sawyer, 2014).

The development of a process to examine service integrity occurrences allows for occurrences to be thoroughly and methodically examined over time. SI-RAP is applied by a panel comprised of technical operations subject matter experts (SMEs) and air traffic control (ATC) SMEs. As part of the SI-RAP process, the panel members will examine the repeatability of the occurrence to classify factors and determine the repeatability of a similar occurrence happening. The purpose of this study was to develop a standard process for assessing the repeatability of these events including the development of the SI-RAP taxonomy. The SI-RAP taxonomy will allow for factors to be identified, classified, compared, and monitored over time and across multiple occurrences. The following sections will introduce the SI-RAP taxonomy along with the associated training and tools that support the application of the taxonomy

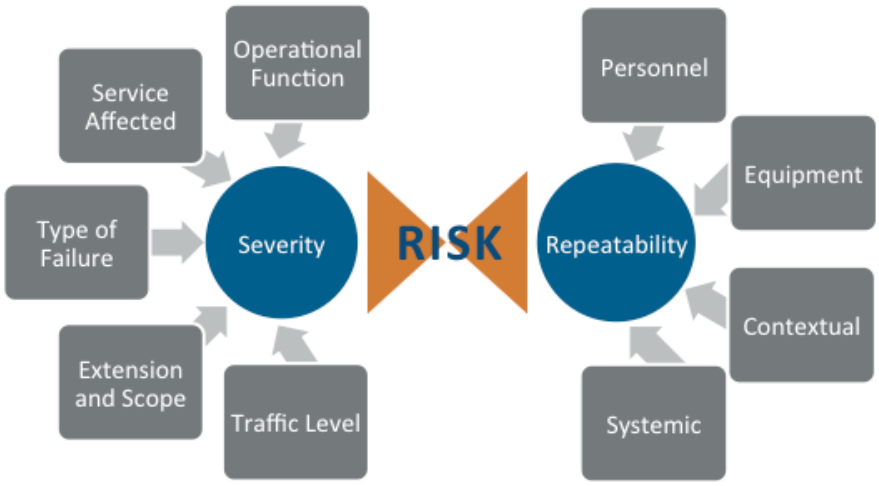

Figure 1. Components of SI-RAP

Introducing the SI-RAP Taxonomy

The SI-RAP taxonomy was developed through a process of taxonomy review, SME opinion elicitation, domain customization, and test case application. The SI-RAP taxonomy follows the structure of the RAT and the Airborne RAP taxonomies and tailors the factors to the domain-specific needs of technical occurrences. Furthermore, the SI-RAP taxonomy incorporates the human factors areas from the AirTracs taxonomy. The SI-RAP taxonomy is comprised of four tiers: Personnel Factors, Contextual Factors, Equipment Factors, and Systemic Factors. Each tier is composed of categories that group related taxonomy factors. The SI-RAP taxonomy is displayed in Figure 2 and Table 1.

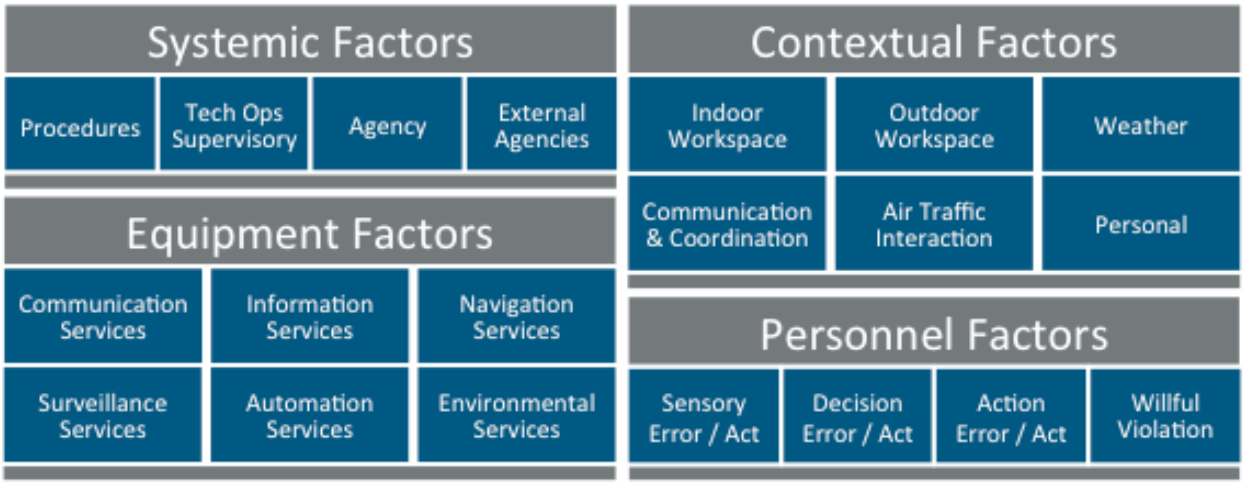

Figure 2. SI-RAP Taxonomy

Table 1. *SI-RAP Taxonomy and Factors*

Systemic Factors
Procedures Factors: Relates to the procedures, checklists, and data an ATSS must use to operate or conduct work. Factors: 6000.15, Maintenance Handbook Procedures, Technical Performance Record, Task Reference Glossary File, Facility Reference Data, Remote Monitoring and Logging System, Checklist, Standard Operating Procedures
Technical Operations Supervisory: Relates to the roles and responsibilities of Technical Operations management and supervisors at local facilities. Factors: Technician Equipment/Tool Readiness, Staffing/Personnel Scheduling, Scheduling of Equipment Outages, Oversight/Assistance, Training Resources and Availability
Agency Factors: Relates to the roles and responsibilities of Technical Operations Agency management and other Technical Operations. Factors: Facility Callback, Safety Culture, Policy, Agency Oversight, Agency Response to Occurrence
External Agency Factors: Relates to how the roles and responsibilities of external, non-FAA actors and organizations. Factors: Contractor Provided Service, Airlines, Contract Towers, Flight Service Stations, Military, Airport Authority, Other ANSPs
Equipment Factors
Communication Services: Relates to the systems, subsystems, or equipment used to transmit or receive voice or data intelligence. Factors: Air/Ground Communication - Main Radio Frequency, Air/Ground Communication - Secondary Radio Frequency, Air/Ground Communication - Backup or Emergency, NAS Voice Switch, Ground Communication –NRCS, Ground Communication – Shout Line/Indirect Access, FAA Provided Telecommunications (Telco), FTI Telco
Information Services: Relates to the systems, subsystems, or equipment used to provide meteorological information and data. Factors: Airport Weather Services - ATIS/ASOS/AWOS, Wind Equipment, Terminal Weather Services, Weather/Radar Processors, National Airspace Data Interchange Network
Navigation Services: Relates to the systems, subsystems, or equipment used to provide guidance, navigational data, or information accomplished either visually or electronically. Factors: VOR, DME, and TACR Systems, ILS and NDB Systems, Lighting - PAPI and VASI
Surveillance Services: Relates to the systems, subsystems, or equipment used for real-time detection and/or display of airborne or ground positional information for ATC. Factors: Primary Air Surveillance, Secondary Air Surveillance (Beacon), Surface Surveillance, ADS-B, Radar
Automation Services: Relates to the computerized systems, subsystems, or equipment used to provide complex automated processing of data elements used in the NAS. Automation uses hardware, software, and various data type inputs, such as communication, weather, surveillance, navigation, infrastructure, and flight information, to provide a composite NAS product. Factors: Terminal Radar Data Processing – ARTS/STARS, En Route Radar Data Processing – HOST/ERAM, Oceanic Radar Data Processing, Surface Movement Guidance and Control, Flight Data Processing, Automated Flight Service Station and FSS Systems, Traffic Management/Flow Systems, SWIM
Environment Services: Relates to the environmental and power systems, subsystems, equipment, or facilities used to support, house, or protect NAS systems, subsystems, and equipment. Factors: HVAC, Commercial Power, Critical Power Distribution System/Uninterruptible Power Supply, E/G, Fire Alarm System, Building Monitor and Control System, Access Control
Contextual Factors
Indoor Workspace: Relates to how the indoor environment, workspace, and tools in which an ATSS or other individual must operate or conduct work. Factors: Distraction – Duty Related, Distraction – Non-Duty Related, Lighting/Vision Restricted, Noise, Ergonomics, Slippery Surface, ATSS Equipment, Site Accessibility, Wildlife, Vandalism
Outdoor Workspace: Relates to how the outdoor environment, workspace, and tools in which an ATSS or other individual must operate or conduct work. Factors: Distraction – Duty Related, Distraction – Non-Duty Related, Lighting/Vision Restricted, Noise, Ergonomics, Slippery Surface, ATSS Equipment, Site Accessibility, Wildlife, Vandalism

Weather: Relates to how weather or meteorological factors can impact an ATSS, other individual, or equipment.
Factors: Fire, Flood, Fog, Glare, Ice, Rain, Snow, Temperature – High, Temperature – Low, Thunderstorm/Lightning, Visibility, Winds, Frost/Ground Heave

Communication & Coordination: Relates to the teamwork factors that are part of successful execution of maintaining the air traffic service integrity. Factors relate to the communication and coordination of planning maintenance, executing maintenance, and returning equipment to service.
Factors: Document/Record in Logs or RMLS, Misspeak/Mishear Information, Equipment Outage Reporting/Status, NOTAM Annotation/Location, Responsiveness, Supervisory Coordination

Air Traffic Interaction: Relates to the actions or inactions by the Air Traffic community (controllers, traffic managers, etc.) that directly impacted an occurrence.
Factors: Controller Misuse of Automation/Equipment, ATC Awareness of Maintenance Event, ATC Interrupts Maintenance, ATC Maintenance Moratorium, ATC Reporting of Events

Personal Factors: Relate to how an individual is impacted by internal stressors or demands.
Factors: On-the-Job Training Being Conducted, Unfamiliar Task/Procedure, Workload – High/Complex, Workload – Low/Underload, Complacency/Vigilance, Automation Reliance, Pattern Assumption/Habits, Time Pressure, Fatigue – Mental, Fatigue – Physical/Muscle, Attitude/Mood

Personnel Factors

Sensory Error/Act: Relates to a person detecting, identifying, and interpreting information through his or her senses. Sensory errors occur when a person's sensory input is degraded and a decision is made based upon faulty information.
Factors: Inspect, Monitor/Observe

Decision Error/Act: Relates to a person developing and determining a plan or response. A decision error occurs when a person's behaviors or actions proceed as intended, but the plan proves to be inadequate and results in, or contributes to, an occurrence.
Factors: Troubleshoot/Diagnose, Coordinate/Describe, Certify/Verify, Prioritization

Action Error/Act: Relates to a person executing a plan, performing a task, implementing a decision, or implementing a course of action. An Action Error/Act occurs when an individual's execution of a routine, highly practiced task relating to procedures, training, or proficiency result in an occurrence.
Factors: Modify, Align/Calibrate, Install/Upgrade, Reset/Configure, Replace/Install, Measure/Test

Willful Violation: Relates to a person willingly and knowingly deviating from rules, regulations, procedures, or policies. This factor should be classified when there is a willful violation relating to a person deliberately disregarding established rules and procedures.
Factors: Willful Violation, Situation Induced Violation

Additionally, when identifying the causal factors, the SI-RAP panel determines the classification level of each factor (Table 2). Panel members classify the factor levels as either causal, contributory, observed, or positive (Berry & Sawyer, 2014).

Table 2. *Factor Classification Levels*

Classification		Factor Definition
Adverse	Causal	An immediate/direct factor that identifies an active error or failure of critical components of equipment, systems, or human error. *Causative: If "A" occurs, then "B" will occur.*
	Contributory	An underlying/root factor that identifies latent errors or failures related to human performance, operating environment, task procedures, training, supervision, or policy that influence the presence of causal factors. *Probabilistic: If "A" occurs, then the probability of "B" occurring increases.*
Neutral	Observed	A factor that is present but the associated impact of the factor on the safety event has not been proven. It is recorded to note its potential influence on the event or actors involved and to be incorporated into trend analysis.
Beneficial	Positive	A factor that positively contributed to the safety of an event. This can include factors or actions that contributed to the detection of, or recovery from, an adverse outcome.

SI-RAP Taxonomy Application

As an accompaniment to the SI-RAP taxonomy, an iPad application was developed to assist the SI-RAP panel in the application of the SI-RAP taxonomy. When a user accesses the SI-RAP taxonomy website, the user must first request a user account and initially set up the account. After the account is approved, the SI-RAP user can access the SI-RAP application and view the homepage (as seen in Figure 3).

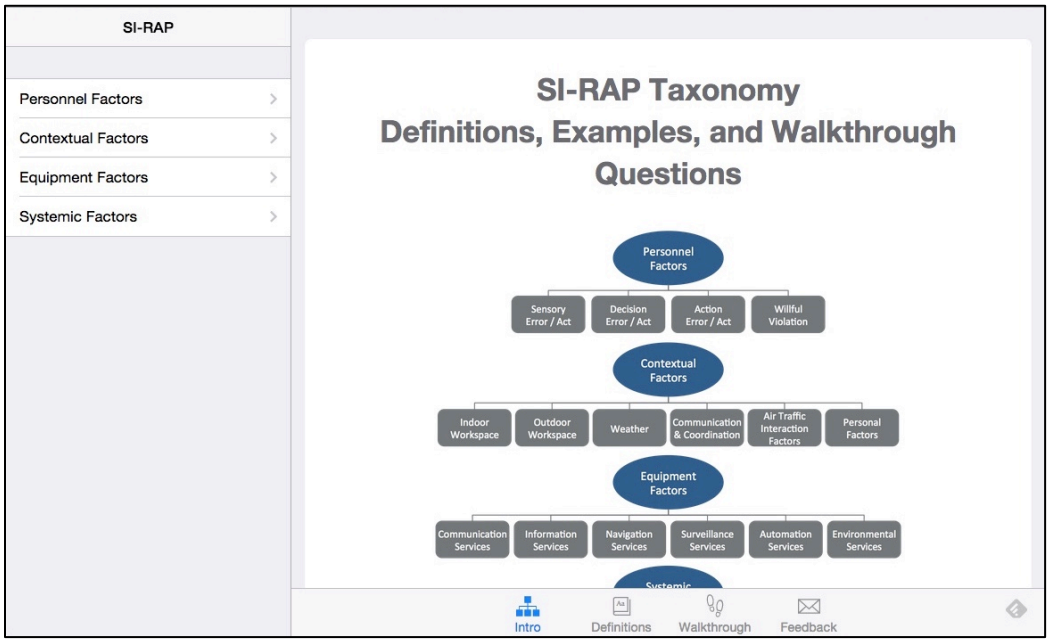

Figure 3: SI-RAP iPad Application – Homepage

From the homepage, the SI-RAP user can access definitions for the various tiers, categories, and factors. The SI-RAP user can also access the example application of each factor as well. In addition to the definitions and examples, the SI-RAP application presents the SI-RAP user with a series of questions that help users to determine which factor to select. These walkthrough questions guide the user to appropriate factors through a series of yes / no questions (Figure 4) and multiple-choice questions (Figure 5).

Figure 4: SI-RAP iPad Application – Walkthrough Question Example 1

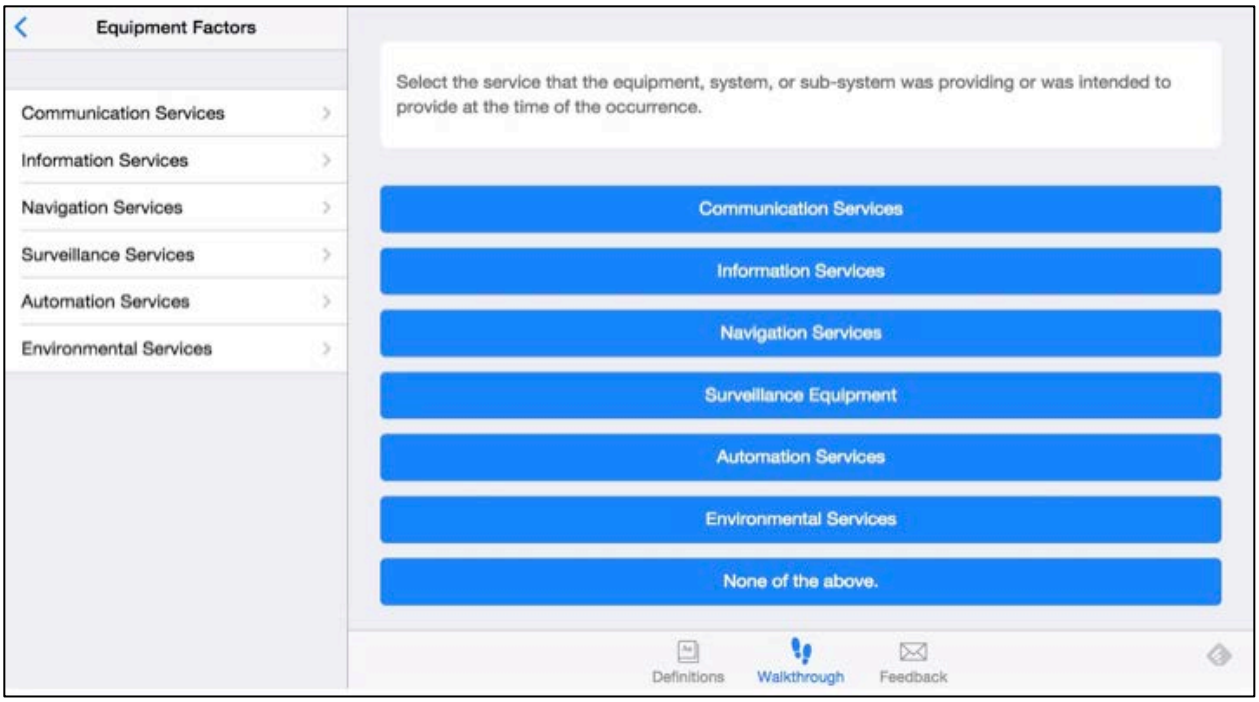

Figure 5: SI-RAP iPad Application – Walkthrough Question Example 2

Acknowledgements

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